The relationship between gas content and pressure gradient in thermal wells.

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Abstract

This research is a subtask of the project between 2009 to 2011 on the geothermal field near Szentes, which used the logged data from the geophysical hydrodynamic and gas separation tests.
On 20 thermal wells from the 1970's there were a few different measurements, from these test results we can conclude on long term processes and trends.
Based on the gas content change, total gas and total methane we create clusters and based on different change trends. Than we compare the clusters with the perforated sections and the pressure gradient logs.
Our goal is to show the correlation between the gas content, the perforated layer and the pressure gradient, if there is any. If exits how they influence each other, Which is both important because the production can be strongly influenced the bubble point and the long-term changes in gas content.

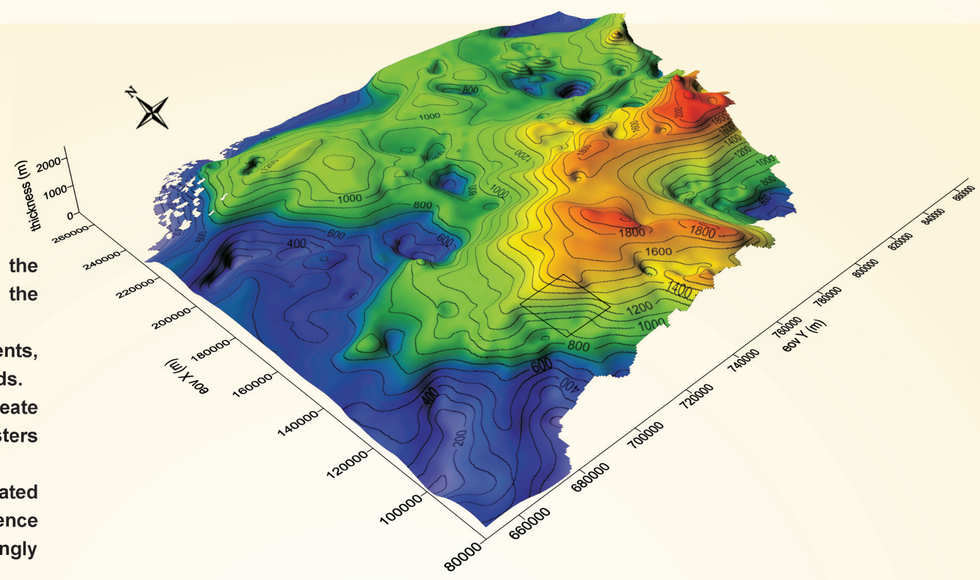


Figure 2. Thickness of the Pannonian layers

Figure 1. Location of the thermal field

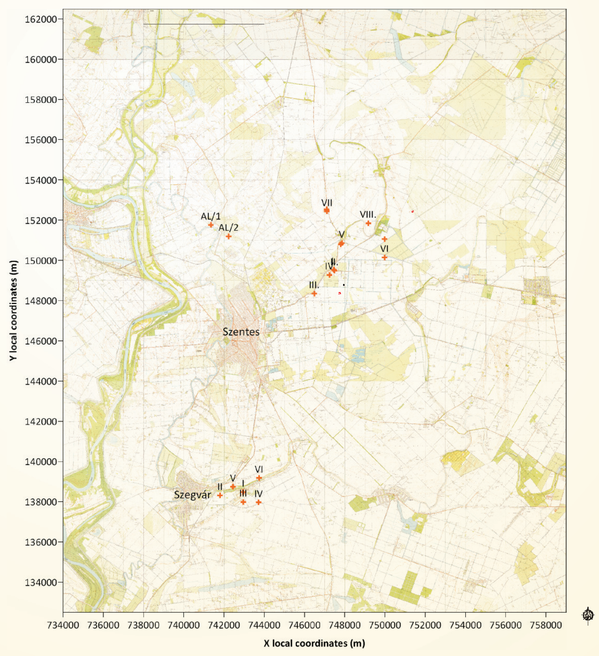


Figure 3. Location of the wells

Geological framework

At the area Szentes the thermal water is located in the Upper-Pannonian layers. In aspect of the hydrogeology the first important formation is the Lower-Pannonian marl. It is dark grey clay marl deposited mainly in an underwater slope (delta slope and basin slope). Superjacent sequence is the littoral sandstone, which had been evolved in delta front-delta plain environment. In this formation is located the three major aquifer. Above these layers lies the variegated clay (swamp facies) with fluvial sand lenses from which is extracted lukewarm water. This is the final of the Pannonian. (Figure 2) Alluvial and eolian sand build up the Quarter which include cold, drinking water.

Well logging

Within the project we realize several kinds of research, on the one hand, complete research is being realized of all the 20 geothermal wells in the area (Figure 3), on the other hand, the mutual interference is being examined among the wells, and we also perform permanent pressure tests to study the territorial effects.
The complete research of the wells means the examination of the structure of the wells (well bottom, casing, place and locking of insulation, place of active perforations etc.) Since this kind of research has never been carried out before. Moreover, dynamic parameter of the wells can be controlled: determination of the flow profile, determination of the transfer in the static well, and the determination of the well hydraulic parameters. During the last research we realize continuous measurement of flow and temperature and also measurement of pressure in the depth and on the surface.

Layers

We classified the perforated layers in three groups. In the first group, there are three wells, in the second there can be found eleven wells, and in the third there are six wells, as we can see in Figure 4. Due to the small numbers of wells in the first group, it cannot be considered representative. In some cases, we were not able to find the results of the previous tests, nevertheless, 20-30 years old trends can be observed.
In case of the majority of the wells, there is a slow decrease of the total methane and gas as well. The wells at the third layer are the exceptions. There are three special cases which differ from the average.
The first one is the Szegvár I. well, there were six gas separations, therefore, we can explain the similar trends through this example. In Figure 5, we can see the Szegvar I. specific total gas content and the specific total methane content. As in the majority of the cases, like in this example, after the construction of the well, the gas content has been decreasing massively. Afterwards, at the beginning of the 80's the gas content was restored at the original level due to reasons that have not been identified so far. It might be a measurement failure.
After that, in the last 30 years, consolidated bat stable decrease can be observed. Interestingly enough, the methane content has been increasing since the last test.
The second type change can be explained with the Szegvár II. well. In Figure 6, we can see that the specific total gas content increases significantly, then a decrease steep can be observed, while, at the same time, the specific methane content decreases slowly. On long term, both of the first and second cases follow the same trend. However, we can assume in both cases that the extreme low values were measured in warm seasons.
The third special type of the gas content changing on Figure 7, can be demonstrated through the Szentes I. II. III. VI/2. VII/2 AL/1 wells. In these wells both the specific total gas and specific total methane increased in the last 30-40 years. The most surprising fact is that these wells were classified in the third layer group.

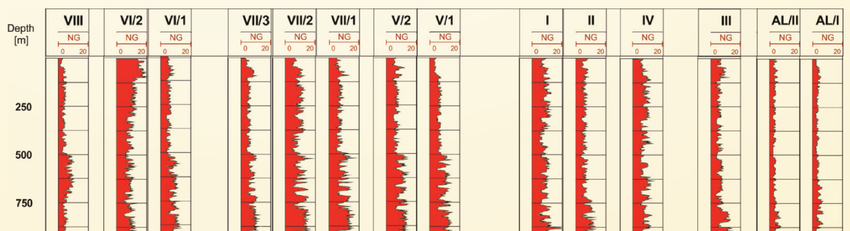


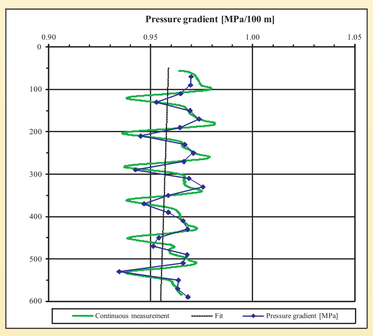
Figure 4. There is three layer groups by the perforation

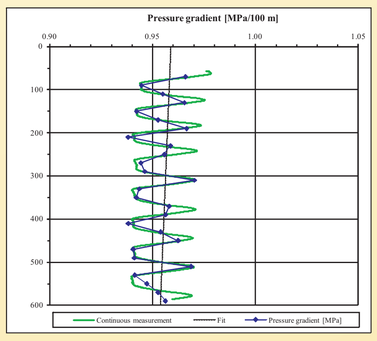
Pressure gradient

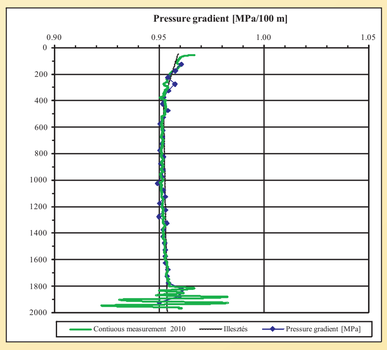
Geo-Log Ltd. uses the pressure gradient measurement to define the bubble point. From this detail, it can be deducted whether the pump is placed to the adequate area or to an unsafe zone, where there is a possibility that the gas separation occurs under the pump, which reduces the production efficiency and the condition of the pump. Most of the pressure gradient tests are conducted in the upper zone of the well, from 500-600 meters to the production pipe. The exceptions are those projects where the whole well pressure gradient log is necessary on the perforated or filtered section. In our current research the most relevant issue is the kind of method we can use to calculate the lower sections' pressure, and the factors which influence this, with special attention to gas content.

Gas Separation

Geo-Log Ltd. realized seventeen gas separations from twenty thermal wells. The examinations were conducted at the end of 2011. Most of the wells can be classified in class "B" by methane content defined by the regulation 12/1997. VII.29 KHVM. The gas content is very diverse from 16,3 l/min to 275 l/min, average 67,05 l/min. Gas content increase can be detected at several wells, which may originate from the fact that different yields might produce different performed layers. The gas content measurement uses a 1600 l main circuit separator, which might cause the operation of the wells to stop for a few days, therefore, it should be implemented at the end of the warm seasons. Problems may arise from connecting a separator or other tools, which also may cause a temporary pause in the production. The gas sampling can be realized exclusively by pumping; in case there is only compressor powered production, deep sampling must be performed. It means that a vacuum sampler is located in the well, and gets the gas sample under the compressor air pipe. The quantity and the temperature might cause further problems. In case the temperature and the quantity of the gas are too high, the gas meter cannot measure it. An example is the well VII/1 near Szentes, where the temperature and the quantity of the gas were too high, consequently, the gas meter on occasions, could not measure it. Despite the fact that Geo-Log Ltd. built a gas-heat exchanger, it could not decrease the







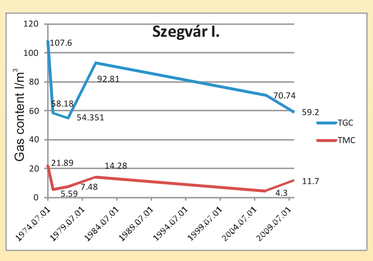


Figure 5. The pressure gradient and gas content of the Szegvar I. well

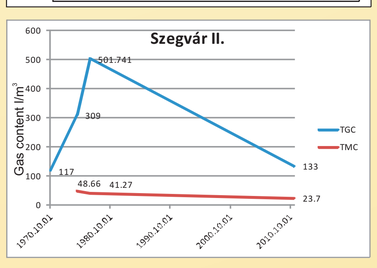


Figure 6. The pressure gradient and gas content of the Szegvar II. well

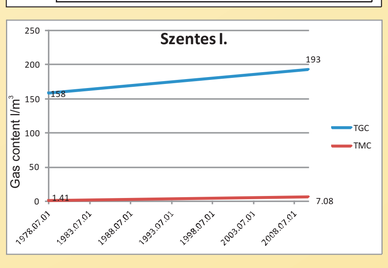


Figure 7. The pressure gradient and gas content of the Szentes I. well

Conclusion

We have only concluded the first stage of the present research. We examined the long term gas content changes and we can assume that by the production, in case of the majority of the wells, during these years, the total gas and total methane content stabilized on an average value. There is an exception, that is, the lower perforated layer group, where the total gas and total methane are also increasing. There is no explanation for this trend. We have several alternative scenarios, one of these is that, as a result of the production, the perforated layer established a connection with other layers which have relatively more methane content, or have so much spare gas content that 30-40 years of production cannot decrease it.
It is highly important to figure out -- at the end of the research -- what factors influence the shape of the pressure gradient curve, especially in the gas content, besides the correlations identified so far. It is also significant to evaluate the production from the sustainability point of view in a 40-50-year perspective and to suggest methods that make the greenhouse gases separation useful and effective, may it be for heating, electricity or power purposes.

Acknowledgements

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